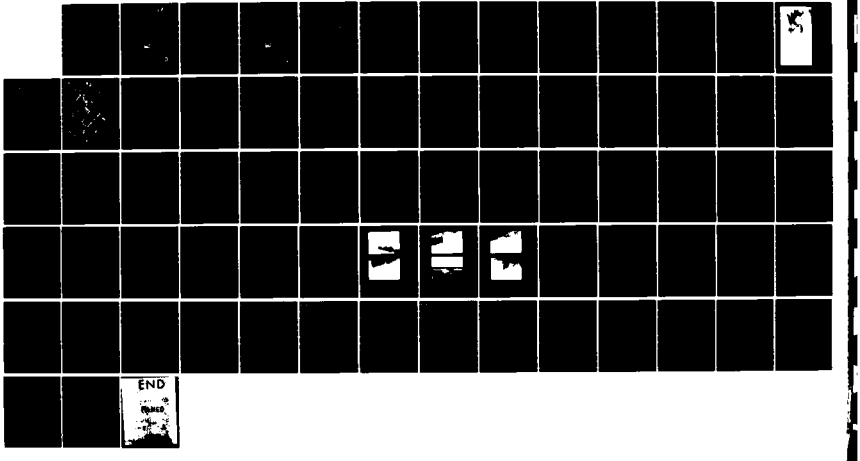
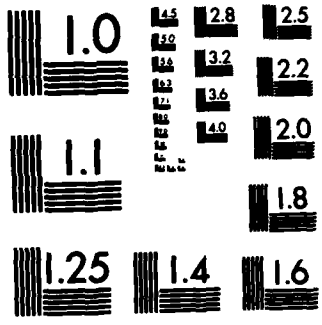
AD-A143 979 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/1
BASHAN LAKE DAM (CT 0.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV FEB 79

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A143 979

LOWER CONNECTICUT RIVER BASIN
EAST HADDAM , CONNECTICUT

BASHAN LAKE DAM
CT 00354

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

FEBRUARY 1979

DTIC FILE COPY

DTIC
ELECTE
AUG 9 1984
S D

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

84 08 08 068

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: CT 00354	2. GOVT ACCESSION NO.: AD A143 979
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Bashan Lake Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS	5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254	12. REPORT DATE: February 1979 13. NUMBER OF PAGES: 50
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Lower Connecticut River Basin
East Haddam, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a gravity stone wall-earth structure. It has a maximum top width of 35 feet and a length of 169 feet. Based upon the visual inspections at the site, the dam appears to be in fair condition. Based upon the size (intermediate) and the hazard classification (significant) of the dam, the test flood will be equivalent to ½ the Probable Maximum Flood.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

LOWER CONNECTICUT RIVER BASIN
EAST HADDAM , CONNECTICUT

BASHAN LAKE DAM
CT 00354

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DTIC
ELECTE
AUG 9 1984
S D
D

FEBRUARY 1979

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Accession For
NTIS GRA&I [X]
DTIC TAB [ ]
Unannounced [ ]
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A/1

Name of Dam:	BASHAN LAKE DAM
Inventory Number:	CT 00354
State Located:	CONNECTICUT
County Located:	MIDDLESEX
Town Located:	EAST HADDAM
Stream:	MOODUS RIVER
Owner:	STATE OF CONNECTICUT
Date of Inspection:	DECEMBER 7, 1978
Inspection Team:	CALVIN GOLDSMITH
	THEODORE STEVENS
	GONZALO CASTRO
	THOMAS KELLER
	CHARLES PHILLIPS

The dam is a gravity stone wall-earth fill structure founded on rock with a near vertical partially arched granite block retaining wall on the downstream face, and a concrete retaining wall on the upstream face. The dam rises approximately 23 feet above the bed of the Moodus River and has a maximum top width of 35 feet and a length of 169 feet. The spillway is a 29 foot long, broad crested weir of trapezoidal cross-section with an inclined sand and gravel upstream approach and a natural rock exposure as a downstream discharge channel. The low level outlet, a stone culvert approximately 2.1 by 2.5 feet in size, discharges at approximate elevation 364.7 to a naturally eroded rock channel. The size, type and invert elevation of the upstream inlet was not ascertained. The gate is operable, but only with difficulty. Immediately downstream of the dam is Moodus Reservoir which has several residences at or near water level which would be in the path of a wave generated by a failure outflow from Bashan Lake Dam.

Based upon the visual inspections at the site, the dam appears to be in fair condition. No instability of the dam was observed, however conditions were identified which could have a direct bearing on the future stability of the dam. One such condition was in the area of the spillway where significant flow was coming from between and below the granite blocks directly under the spillway crest. The other major concern is the insufficient capacity of the spillway itself. There are other areas requiring monitoring and minor maintenance, as well.

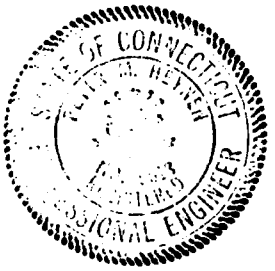
Based upon the size (Intermediate) and the hazard classification (Significant) of the dam in accordance with Corps of Engineers guidelines, the Test Flood will be equivalent to one-half the Probable Maximum Flood (PMF). Peak inflow to the lake is 2200 cfs; peak outflow (Test Flood) is 700 cfs with the dam overtopped 1.0 feet. Based upon our hydraulics computations, the spillway capacity is 165 cubic feet per second (cfs), which is equivalent to 24% of the Test Flood. The peak failure outflow of 3000 cfs from the dam breaching would develop a 10 foot wave immediately downstream of the dam, which would have potential to cause loss of life and extensive property damage due to waves and flooding downstream at Moodus Reservoir.

It is recommended that further studies be undertaken to perform a more refined hydraulic/hydrologic study to determine the best way to increase the ability of the spillway to pass a greater percentage of the Test Flood.

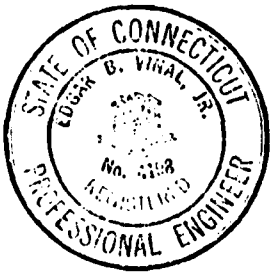
A study should also be undertaken by a registered engineer qualified in dam inspection to examine the seepage from beneath the spillway and recommend remedial measures to curb this flow.

An operation and maintenance plan should be instituted. Maintenance and remedial measures should be performed as described in Section 7.

The above recommendations and remedial measures which are outlined in Section 7, should be instituted within one year of the owner's receipt of this report.



Peter M. Heynen, P.E.
Project Manager
Cahn Engineers, Inc.



Edgar B. Vinal Jr., P.E.
Senior Vice President
Cahn Engineers, Inc.

This Phase I Inspection Report on Bashan Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL C. COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

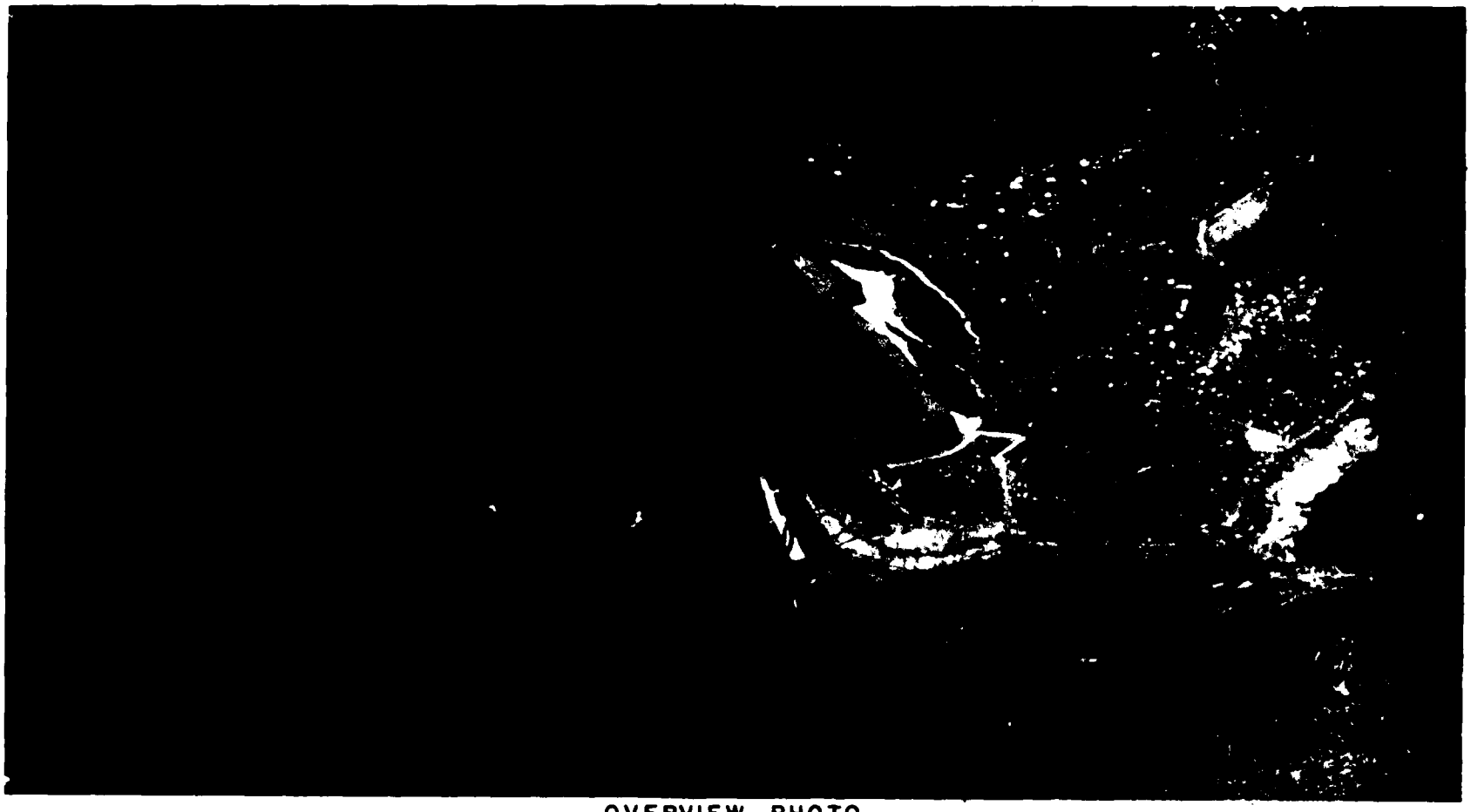
It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

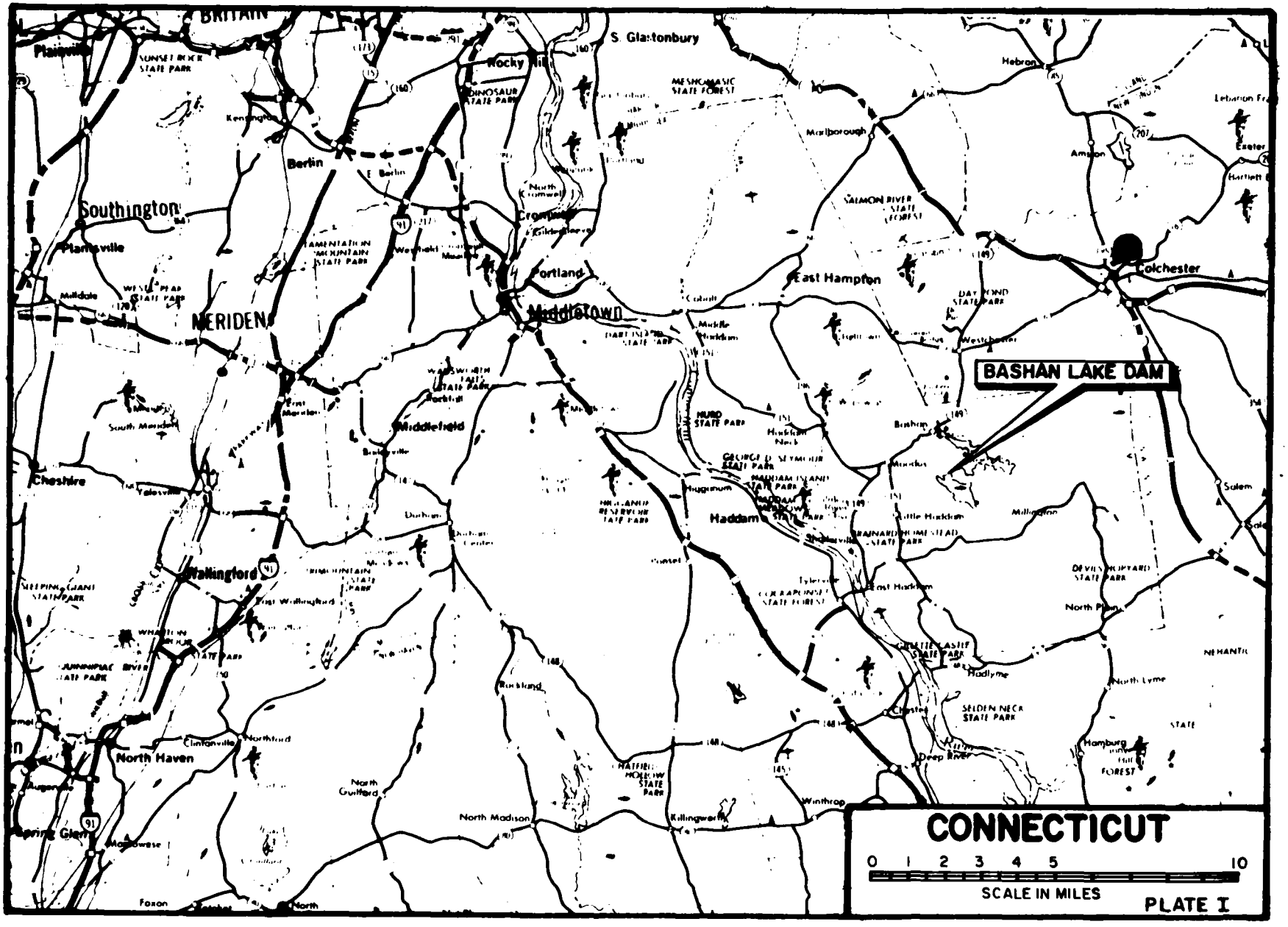
SECTION 7: ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

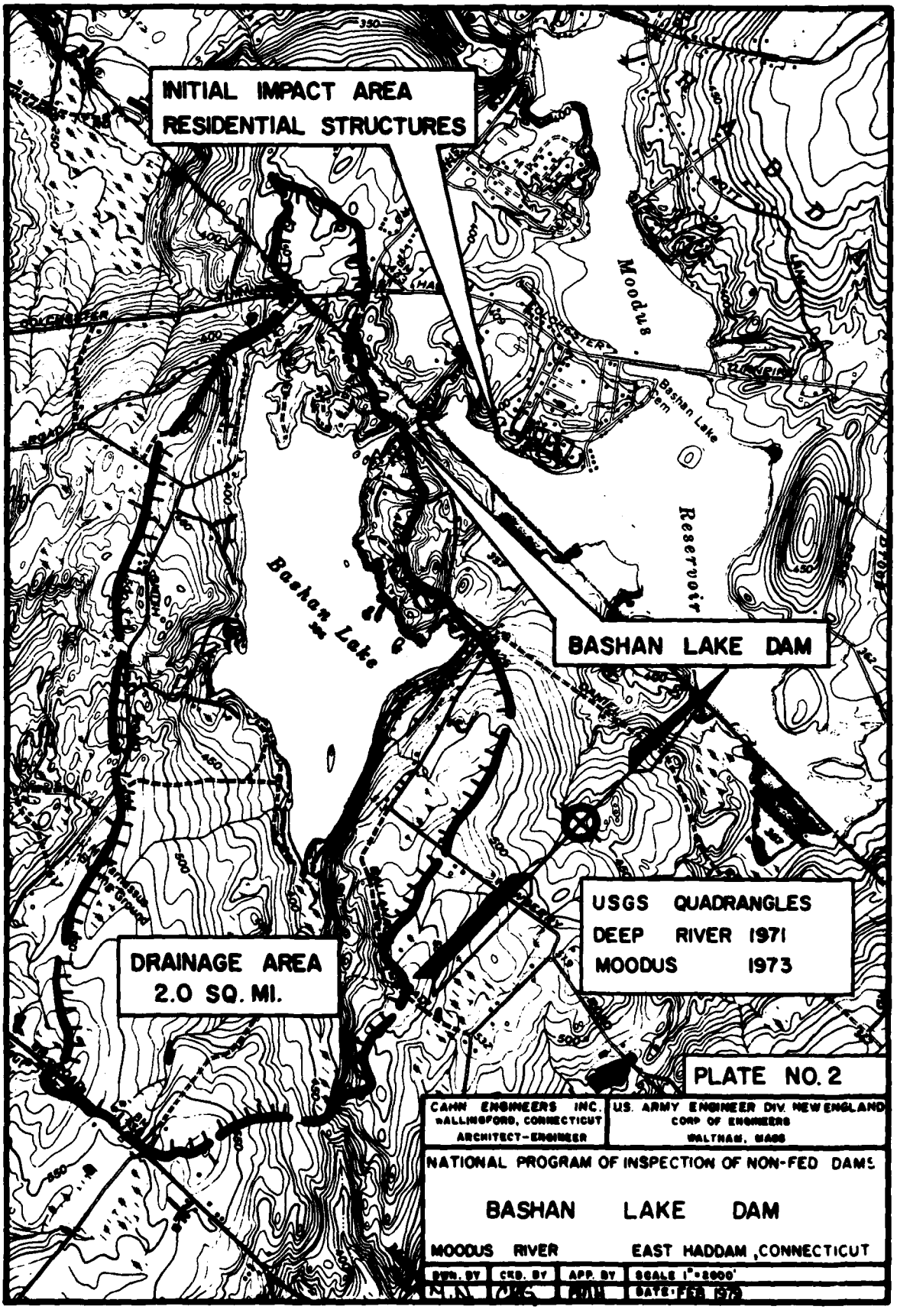
APPENDIX



OVERVIEW PHOTO

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS. CAHN ENGINEERS. INC. WALLINGFORD, CONN. ARCHITECT —— ENGINEER	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	BASHAN LAKE DAM MOODUS RIVER	EAST HADDAM CONNECTICUT	DATE FEB 1979 CE # 27 595 PAGE ix


BRITAIN
Plainville
SUNSET RIDGE STATE PARK
Kensington
Berlin
E. Berlin
Southington
Plantsville
Middlefield
Cheshire
Yalesville
Durham
Wallingford
North Haven
Clintonville
Northford
North Guilford
Rockland
North Madison
Killingworth
Foxon
S. Glastonbury
Rocky Hill
DINOSAUR STATE PARK
MESHOMASIC STATE FOREST
Cromwell
Portland
Middletown
MERIDEN
Westfield
Colony
Middle Haddam
Haddam
Hebron
Marlborough
Amston
Lebanon
Exeter
Hartlett
SALMON RIVER STATE FOREST
East Hampton
Colchester
DAY KIMBALL STATE PARK
Westchester
BASHAN LAKE DAM
HURD STATE PARK
Bashan
Salem
Millington
East Haddam
North Plain
Hadlyme
North Lyme
SELDEN NECK STATE PARK
Deep River
Winthrop
Hamburg
CONNECTICUT
0 1 2 3 4 5 10
SCALE IN MILES
PLATE I


INITIAL IMPACT AREA
RESIDENTIAL STRUCTURES
BASHAN LAKE DAM
USGS QUADRANGLES
DEEP RIVER 1971
MOODUS 1973
DRAINAGE AREA
2.0 SQ. MI.
Moodus
Bashan Lake
Reservoir
Bashan Lake
PLATE NO. 2
CAHN ENGINEERS INC.
WALLINGFORD, CONNECTICUT
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORP OF ENGINEERS
WALTHAM, MASS
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
BASHAN LAKE DAM
MOODUS RIVER
EAST HADDAM, CONNECTICUT
DWN. BY
CKD. BY
APP. BY
SCALE 1"=2000'
DATE FEB. 1978

PHASE I INSPECTION REPORT

BASHAN LAKE DAM

SECTION I

PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program

The purposes of the program are to:

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

(2) Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program

The scope of this Phase I inspection report includes:

(1) Gathering, reviewing and presenting all available data that can be obtained from the owners, previous owners, the state and other associated parties.

(2) A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

(3) Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

(4) An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features on the dam which need corrective action and/or further study.

1.2 Description of Project

a. Description of Dam and Appurtenances - The 169 foot long dam is comprised of earth fill with a granite block retaining wall as the downstream face and a concrete retaining wall as its upstream face. At its highest point, the dam rises 23 feet above the bed of the Moodus River with the maximum width of the top of the dam being approximately 35 feet. The downstream face is nearly vertical, and the upstream face is battered approximately 3.8 horizontal to 1.0 vertical, based upon field measurements. The spillway is a broad crested weir of trapezoidal cross-section with an upstream sand and gravel inclined approach. The spillway is approximately 29 feet long and has a 5.5 foot wide concrete cap over the stone masonry construction. The dam is founded on bedrock which surfaces immediately downstream of the spillway and forms the spillway discharge channel. The low level outlet, a conduit approximately 2.1 feet by 2.5 feet in size, discharges into a naturally eroded rock channel, as well. As the inlet was underwater, the size, type and invert elevation of the upstream inlet was not ascertained. A chain link fence approximately 6 feet high runs along the full length of the dam, including the spillway. Granite blocks and wooden planks were placed along the spillway crest to provide access to the dam when water is flowing over the spillway.

b. Location - The dam is located on the Moodus River in a rural area of the Town of East Haddam, County of Middlesex, State of Connecticut. The dam is shown on the Deep River USGS Quadrangle Map having coordinates latitude N 41° 29.9' and longitude W 72° 25.0'. Moodus Reservoir is located immediately downstream of Bashan Lake Dam.

c. Size Classification (INTERMEDIATE) - The dam impounds in excess of 3000 acre-feet of water (refer to Appendix Section D, page 7) with the lake level at the top of the dam. According to the Recommended Guidelines, a dam with storage of between 1000 and 50,000 acre-feet is classified as of intermediate size.

d. Hazard Classification (SIGNIFICANT) - Downstream of Bashan Lake Dam along the shoreline of Moodus Reservoir, there are several residential structures from 2.6 to 3.5 feet above the water level which possibly would be in the path of a flood wave on Moodus Reservoir due to a failure of Bashan Lake Dam. These residences and the recreational usage of the lake yield potential for loss of life in the event of a dam failure.

e. Ownership

State of Connecticut
Department of Environmental Protection
Division of Conservation and Preservation
R.R. 2, Box 150A.
East Hampton, Connecticut 06424
Mr. John Spencer (203)295-9523
Mr. Charles Phillips (203)295-9523

f. Operator - None

g. Purpose of Dam - Recreational uses now. Originally built for Brownell Mill.

h. Design and Construction History - The following information is believed to be accurate, however the majority of this information was based on conversations with Charles Phillips of the State of Connecticut and with Mr. Crary Brownell, a former owner of the dam, and the son of the man who originally constructed the dam.

The dam was originally constructed to power the Brownell Mill. The partial arch construction, one of the first of its type in Connecticut, was accomplished using granite blocks founded on bedrock for the length of the dam and utilizing an upstream earth fill embankment. At some later date, the upstream concrete retaining wall was constructed to control leakage through the dam. Sand from the lake bottom used for the concrete produced poor results and the concrete began to deteriorate. The hurricane of 1938 sent water 3 to 4 inches over the dam and washed out the mill below the dam. As a result, the dam was thoroughly

overhauled, which included raising the dam approximately a foot, and resurfacing the upstream face of the dam with concrete. At this time the gate structure was installed as well. The dam remains substantially unchanged since then. On September 27, 1966 the Moodus Reservoir Company turned Bashan Lake Dam over to the State of Connecticut.

i. Normal Operational Procedures - The valves are normally opened only in times of very high water and usually with difficulty. The lake takes quite a long time to fill and it is normally kept as full as possible by the State of Connecticut for the lakefront residents. However, occasionally the lake level is lowered during September to permit residents to perform waterfront maintenance on their property.

1.3 Pertinent Data

a. Drainage Area - The drainage area is 2.0 square miles of rolling, wooded terrain with scattered rural type of developments.

b. Discharge at Dam Site - Discharge from the reservoir is from the stone culvert low level outlet and from over the spillway.

Outlet work (conduits):	2.1' x 2.5' stone culvert, outlet el. 364.7
Maximum known flood at damsite:	N/A
Ungated spillway capacity @ top of dam:	165 cfs @ el. 387.5
Ungated spillway capacity at test flood elevation:	165 cfs @ el. 387.5
Gated spillway capacity at normal pool el.:	N/A
Gated spillway capacity at test flood elevation:	N/A
Total spillway capacity at test flood el.:	165 cfs @ el. 387.5
Total project discharge @ test flood el.:	N/A

c. Elevations - (Feet above M.S.L., U.S.G.S. Datum As no elevations for the dam were available from existing information, the water surface elevation shown on the Deep River U.S.G.S. Quadrangle Map for Bashan Lake was assumed to be the dam spillway crest elevation. All other M.S.L. elevations are relative to the assumed spillway crest elevation).

Streambed at centerline of dam:	361.2
Maximum tailwater:	N/A
Upstream portal invert diversion tunnel:	N/A
Recreation pool:	386.0 (Assumed)
Full flood control pool:	N/A
Spillway crest:	386.0
Design surcharge (Original Design):	N/A
Top of Dam	387.5±
Test flood design surcharge:	388.5±

d. Reservoir

Length of Maximum pool:	7400+ ft/
Length of recreation pool:	7400 ft.
Length of flood control pool:	N/A

e. Storage

Recreation pool:	2760 ac.-ft.
Flood control pool:	N/A
Spillway crest pool	2760 ac.-ft.
Top of dam:	3200 ac.-ft. (See Appendix Section D-7)
Test flood pool:	N/A

f. Reservoir Surface

Top of Dam:	276+ acres
Test flood pool:	276+ acres
Flood-control pool:	N/A
Recreation pool:	276 acres
Spillway crest:	276 acres

g. Dam

Type:	stonewall-earth fill with upstream concrete wall.
Length:	169 ft.
Height:	23 ft. (Max.)
Top Width:	Varies from 20 to 35 ft.
Side Slopes:	3.8H to 1V (upstream) Near vertical (downstream)
Zoning	None known
Impervious Core	None known
Cutoff:	Founded on ledge rock
Grout curtain:	N/A
Other:	N/A

h. Diversion and Regulating Tunnel - N/A

i. Spillway

Type:	Broad-crested weir of granite blocks with concrete cap.
Length of weir:	29 ft.

Crest elevation:	386
Gates:	None
U/S Channel:	4H to 1V (estimated)
D/S Channel:	2H to 1V (variable)
General:	Spillway discharge is natural rock exposure.

j. Regulating Outlet

Invert:	364.7 (discharge invert)
Size:	2.1' x 2.5' rectangular
Description:	Stone culvert
Control Mechanism:	Upstream gate valve
Other:	N/A

SECTION 2: ENGINEERING DATA

2.1 Design

a. Available Data - The available data consists of the State of Connecticut dam inventory sheet, and two property maps, one of the area around the dam and one of Bashan Lake for the State of Connecticut by Chandler and Palmer, Engineers, dated May 25, 1967.

b. Design Features - No information was available.

c. Design Data - There were no engineering values, assumptions, test results or calculations available for the original construction or the later modifications described in Section 1.2 g..

2.2 Construction

a. Available Data - No information was available.

b. Construction Considerations - No information was available.

2.3 Operations - No formal operations or lake level records are known to exist.

2.4 Evaluation

a. Availability - No existing information was available other than from conversations with Chuck Phillips of the State of Connecticut and Mr. Crary Brownell, a former owner of the dam. The owner made the dam available for visual inspection.

b. Adequacy - The absence of any detailed engineering data made it impossible to perform an in-depth assessment of the dam, therefore, the final assessment of this investigation must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and approximate hydrologic judgement.

c. Validity - The information received verbally from the State and from Mr. Brownell appears reasonable and shows no significant discrepancies with what was observed during the visual inspection.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General - The general condition of the dam is good. However, there was a significant seepage flow from the downstream face of the dam below the spillway crest. Inspection revealed areas requiring monitoring, minor maintenance, and minor alterations.

b. Dam - The water level varied from 3.4 feet below the top of the dam during our first visual inspection, to slightly less than 1 foot below the top of the dam during our latest visit.

Crest - The crest of the dam is a grassed earth embankment which showed no signs of cracking or subsidence, as shown in Photo 5. A small sapling is growing on the dam crest near the right abutment just behind the downstream granite block retaining wall. A chain link fence runs along the crest of the dam and spillway approximately 3 feet upstream of the granite block wall.

Downstream Face - The downstream face is a near-vertical granite block wall, partially arched in the area of the low level outlet as shown in Photo 6. Areas of the downstream face are covered with a thin layer of concrete facing as can be seen in Photo 2. With the exception of below the spillway crest, the downstream face is generally in good condition with only 2 small seeps observed. One was several feet above and to the left of the outlet channel. The other seep was a few feet below the top of the dam, immediately to the right of the spillway section. The flow of water was very small and was observed coming out from between stone blocks where mortar was partially or totally absent. No evidence of soil transport was observed.

At the time of our initial site visit (December 7, 1978) the water level was about 3.4 feet below the top of the dam as shown in Photo 1. During subsequent visits to the site on January 15, 22 and 25, 1979, after considerable rainfall, the water level had risen to the spillway crest and then up to approximately 6 inches over the crest. The higher water levels have identified paths of flow under the concrete spillway cap. This flow discharges from between the granite blocks and from between the lowest granite block and natural rock exposure directly beneath the spillway crest. The condition of the downstream face in this area beneath the spillway crest must be described as only fair.

Due to the significant discharge of this area, there is a possibility that movement and initial failure of these spillway blocks could initiate further failures of the downstream granite block wall and possibly of the dam itself.

Upstream Face - The upstream face of the dam is a concrete wall covered with an additional thin concrete facing as shown in Photos 1 and 3.

There are several vertical cracks in the concrete of the upstream face of the dam which extend across the top of the wall. Some of the cracks have been filled with a black tar-like material. All observed cracks are hairline with the exception of a crack with a width of about 1/2-in, located 25 ft to the left of the outlet works. This crack is shown in Photo 3 as viewed from the outlet works. An overhead view is shown in Photo 4. The crack could be seen to extend to the floor of the reservoir which is about 13 ft from the top of the dam. The depth of the crack was measured with an 1/8-in wide ruler near the crest where it had a maximum depth of 2 inches. Minor spalling of the concrete has occurred in the vicinity of this crack at the top of the wall. The soil surface at the crest of the dam in the vicinity of the crack was not significantly different than in other portions of the crest, nor was there seepage or cracking observed on the downstream face at the station of the upstream crack.

Spillway - The spillway consists of a 5.5 foot wide concrete cap over the downstream face granite block wall. The chain link fence across the spillway extends down to within 6 inches of the spillway crest. Two fence posts are located in the spillway crest. There is also a walkway formed by two granite blocks spanned by wooden planks across the spillway. The approach channel upstream of the spillway has a coarse sand and gravel bottom and is estimated very roughly to slope off into the lake at an inclination of 4 horizontal to 1 vertical.

c. Appurtenant Structures - The spillway discharges onto a natural rock face which drains to the low level outlet discharge channel carved into rock. The exposed rock face is a foliated gneiss. A small seep was observed through the rock face about 30 feet downstream of the spillway crest.

d. Downstream Channel - The channel downstream of the dam has a gravel bottom and a steep rock face along its right bank. Several small seeps or springs were observed on the

right bank from approximately 50 to 100 feet downstream of the dam. The area along the side of the channel is heavily wooded to where it runs under the roadway and into Moodus Reservoir roughly 200 yards downstream of the dam.

3.2 Evaluation

Visual inspection indicates the dam is in good condition, however due primarily to the significant amount of flow observed under the spillway, the downstream face of the dam in this area is in fair condition. Other areas which will require attention and/or monitoring, include the tree on the right portion of the crest, the fence across the spillway, and the crack in the upstream face of the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Regulatory Procedures

The low level outlet remains closed except in times of very high water, due to the length of time the lake takes to fill and the recreational demand for the lake.

4.2 Maintenance of Dam

Other than during periodic inspections of the dam by the State, maintenance of the dam is minimal. Minor maintenance would be performed should the State inspections deem it necessary.

4.3 Maintenance of Operating Facilities

To the best of our knowledge, no maintenance of the operating facilities has been performed on the operating facilities since the State acquired the dam in 1966.

4.4 Description of Any Formal Warning System In Effect

No formal warning system is in effect.

4.5 Evaluation

The operation and maintenance procedures should be improved upon. A formal program of operation and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Also, a formal warning system should be developed and implemented within the time frame indicated in Section 7.1C. Remedial operation and maintenance recommendations are presented in Section 7 and include:

a. Opening of the low level outlet at least once a year, and performing the required maintenance to keep the gate easily operable.

b. Inspections of the dam on a routine monthly basis, as well as during times of high water to detect any as yet undiscovered seeps, and to monitor existing seeps. The relative positions of the granite blocks between which seepage occurs should be observed during each inspection, and any movement noted. Photographic evidence of seepage should be acquired from each inspection to provide an effective method to compare seepage flows from one inspection to the next.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General - The lake is basically a high storage project with the lake area constituting a large percentage of the drainage area.

b. Design Data - No computations could be found for the original dam construction or later raisings.

c. Experience Data - The maximum known height of water over the spillway was during the 1938 hurricane when the dam was overtopped by 3 or 4 inches, which is equivalent to just less than 2.0 feet of water over the spillway. During this flow, the Brownell Mill just downstream of the dam was washed out. This information was received verbally from Mr. Crary Brownell, the 90 year old former owner of the dam.

d. Visual Observations - The chain link fence which is 6 inches above the spillway crest, the granite blocks, wooden planks, and the fence posts in the spillway could easily cause debris to block up the spillway during high water.

e. Test Flood Analysis - The test flood inflow for this significant hazard, intermediate size dam is equivalent to one half of the Probable Maximum Flood (PMF), which is approximately 2200 cubic feet per second (cfs).

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March, 1978, peak inflow to the reservoir is 2200 cfs (Appendix D-7); peak outflow (Test Flood) is 700 cfs with the dam overtopped approximately 1.0 ft (Appendix D-13). Based upon our hydraulics computations, the spillway capacity is 165 cfs, which is roughly 24 percent of the Test Flood. Parallel computations assuming the Test Flood based upon the full PMF figure are presented in Appendix Section D.

Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak failure outflow from the dam breaching would be 3000 cubic feet per second, which would develop a 10 foot wave immediately downstream of the dam at the entrance to Moodus Reservoir. After the flood wave from Bashan Lake Dam breaching would subside, the total rise in the water level of Moodus Reservoir would be approximately 2.6 feet.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - The visual inspection revealed that for water levels close to the spillway crest, flow occured between the granite blocks comprising the downstream face of the dam immediately below the spillway crest. Water flows from upstream of the concrete spillway cap, under the spillway and between the granite blocks to the spillway discharge channel. The downstream face of the dam is constructed of granite blocks and is continuous with the section under the spillway. In the event of a very high water level which overtops the dam, it is conceivable that one or more of these granite blocks below the spillway could become dislodged, which would probably lead to a progressive failure of the remaining portion of the wall. With a failure of the downstream face while the dam is being overtopped, a subsequent failure of the remaining earth and concrete portions of the dam is possible.

b. Design and Construction Data - No written data was available pertaining to the design or construction of the dam. The only information obtained was as a result of a conversation with Mr. Crary Brownell, a former owner and son of the original builder of the dam.

c. Operating Records - According to Mr. Brownell, the dam used to leak substantially, which was why the upstream concrete portion of the dam was constructed. No information pertaining to past instability problems was available.

d. Post Construction Changes - According to Mr. Brownell, the original dam consisted of the downstream granite block wall with an upstream earthen embankment. At a later, unspecified date, the upstream concrete wall was built to curb leakage. After the 1938 hurricane, a thorough overhaul of the dam was performed, which included raising the dam "about a foot" and resurfacing the upstream face and portions of the downstream face with concrete. The gate was installed also at this time. No further alterations have been performed since. No further information was available.

e. Seismic Stability - The dam is located in Seismic Zone 1, and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - Based upon visual inspections at the site and past performance, the dam appears to be in good condition. No evidence of structural instability of the dam was observed, however conditions were identified which could have a direct bearing on the future stability of the dam, principally the seepage under the spillway cap and the inadequate spillway capacity. There are some other areas requiring attention, as well.

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, peak inflow to the reservoir is 2200 cubic feet per second; peak outflow (Test Flood) is 700 cubic feet per second with the dam overtopped approximately 1.0 feet. Based upon our hydraulics computations, the spillway capacity is 165 cubic feet per second, which is equivalent to approximately 24 percent of the Test Flood which is one-half the Probable Maximum Flood.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the dam must be based solely on visual inspection, the past performance of the dam, and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within 1 year of the owner's receipt of this report.

d. Need for Additional Information - There is a need for more information as recommended in Section 7.2.

7.2 Recommendations

1. Based upon the rough computations in Appendix D, the dam spillway capacity will be exceeded by the Test Flood. More sophisticated flood routing should be undertaken by hydrologists/ hydraulics engineers to refine the Test Flood figures. A study should be undertaken and recommendations made to increase the spillway capacity to an acceptable level based upon the refined Test Flood figures.

2. An investigation should be undertaken by a registered engineer qualified in dam design to determine a method of preventing the seepage flow under the spillway crest. A suggested approach would be to seal the bottom of the upstream spillway approach channel against seepage by a

concrete lining or a similar impervious material. Such an approach could, however, have an adverse effect on the stability of the structure; therefore, a stability check should be performed prior to the recommendations being finalized.

3. The chain link fence presently running along the crest of the dam and spillway should be removed, however alternate safety precautions must be taken to limit access to the downstream edge of the dam or to the complete dam itself. An alternative to the present chain link fence should be recommended by a registered professional engineer and incorporated into the recommendations in Section 7.2.2, above.

7.3 Remedial Measures

a. Operation and Maintenance Procedures - The following measures should be undertaken within the time frame indicated in Section 7.1.C, and continued on a regular basis, where applicable.

1. Round-the-clock surveillance should be provided by the owner during periods of unusually heavy precipitation. The owner should develop a formal warning system with local officials for alerting downstream residents in case of an emergency.

2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference. This program should include monitoring of the seepage, complete with photographic records, on a monthly basis to watch for any worsening of the seepage. The relative positions of the granite blocks near the spillway adjacent to the seepage should be observed at this time also, and any movement recorded. Modifications performed as a result of the investigation in Section 7.2.2 may eliminate the need for this monthly inspection program.

3. A program of inspection by a registered professional engineer qualified in dam inspection should be instituted on an annual basis. The inspections should be of a technical nature and should include the opening of all operable low level outlets.

4. Grass growing on the crest should be cut as part of routine maintenance. A small tree on the crest near the right abutment should be removed.

5. Cracks in the concrete of the upstream face should be repaired.

6. Seeps through the downstream face of the dam other than those near the spillway, should be examined periodically to determine changes in flow or evidence of soil transportation.

7. The low level outlet should be maintained regularly to render it easily operable.

7.4 Alternatives

This study has identified no practical alternatives to the above recommendations and remedial measures.

APPENDIX

SECTION A: VISUAL OBSERVATIONS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT EASHAN LAKE DAM DATE: DEC. 7, 1978

TIME: 8:30 A.M.

WEATHER: SUNNY, 40°

W.S. ELEV. 384.1 U.S. _____ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. CALVIN GOLDSMITH	CRG	CAHN ENGINEERS, INC.
2. TED STEVENS	TS	CAHN ENGINEERS, INC.
3. GONZALO CASTRO	GC	GEOTECHNICAL ENGR, INC.
4. THOMAS KELLER	TK	GEOTECH. ENGRS, INC.
5. CHUCK PHILLIPS	CP	STATE OF CT. U.E.P.
6.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	EARTH DAM WITH U/S AND D/S RETAINING WALLS	CRG, TS, GC, TK	
2.	U/S GATE STRUCTURE	CRG, TS, GC, TK	
3.	LOW LEVEL OUTLET	CRG, TS, GC, TK	
4.	SPILLWAY	CRG, TS, GC, TK	
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT BASHAN LAKE DAM DATE DEC. 7, 1978

PROJECT FEATURE EARTH DAM W/ U/S AND D/S WALLS BY CRG, TSG, TK

AREA EVALUATED		CONDITION
DAM EMBANKMENT		
Crest Elevation		
Current Pool Elevation		EL. 384 (LATER VISIT 1/25/79 - WATER AT EL. 386.5)
Maximum Impoundment to Date		NA
Surface Cracks		SOME IN U/S GUNNITE - NONE IN EARTH CREST
Pavement Condition		GUNNITE IN GOOD CONDITION W/ ONLY MINOR LOCAL SPALLING
Movement or Settlement of Crest		NONE OBSERVED
Lateral Movement		NONE OBSERVED
Vertical Alignment		GOOD
Horizontal Alignment		ARCHED DAM - TOO IRREGULAR TO JUDGE
Condition at Abutment and at Concrete Structures		GOOD
Indications of Movement of Structural Items on Slopes		NA
Trespassing on Slopes		NA
Sloughing or Erosion of Slopes or Abutments		NONE OBSERVED
Rock Slope Protection-Riprap Failures		NA
Unusual Movement or Cracking at or Near Toes		NONE OBSERVED
Unusual Embankment or Downstream Seepage		MAJOR FLOW BENEATH SPILLWAY - MINOR SEEPAGE IN D/S FACE TO RT. OF LOW LEVEL OUTLET
Piping or Boils		NONE OBSERVED
Foundation Drainage Features		NONE OBSERVED
Toe Drains		NONE KNOWN
Instrumentation System		NONE KNOWN

PERIODIC INSPECTION CHECK LIST

PROJECT BASHAN LAKE DAM DATE DEC. 7, 1978

PROJECT FEATURE U/S GATE STRUCTURE BY CRG, TS, GC, TK

AREA EVALUATED		CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE		INVERT ELEVATION NOT KNOWN- GATE OPERABLE WITH DIFFICULTY
a) Approach Channel		
Slope Conditions		NOT KNOWN
Bottom Conditions		SILTED
Rock Slides or Falls		NONE
Log Boom		NONE
Debris		NONE OBSERVED
Condition of Concrete Lining		NA
Drains or Weep Holes		NA
b) Intake Structure		
Condition of Concrete		GOOD - SURFACE GUNNITE
Stop Logs and Slots		NA

PERIODIC INSPECTION CHECK LIST

PROJECT EASHAN LAKE DAM DATE DEC. 7, 1978

PROJECT FEATURE [illegible] LEVEL OUTL... BY CKG, ISWG, IK

AREA EVALUATED	CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	GRANITE BLOCK WITH PARTIAL GUNNITE FACING - GOOD CONDITION
Rust or Staining	NONE OBSERVED
Spalling	SOME DETERIORATION OF GUNNITE
Erosion or Cavitation	NONE OBSERVED
Visible Reinforcing	NONE OBSERVED
Any Seepage or Efflorescence	TO RIGHT OF OUTLET - MINOR
Condition at Joints	LITTLE OR NO MORTAR, BUT ONLY MINOR SEEPAGE
Drain Holes	NONE OBSERVED
Channel	
Loose Rock or Trees Overhanging Channel	BOTH SIDES OF CHANNEL, BUT IS NOT A CONCERN
Condition of Discharge Channel	BEDROCK & GRAVEL BOTTOM - GOOD CONDITION

PERIODIC INSPECTION CHECK LIST

PROJECT BACHMAN LAKE DAM DATE DEC. 7, 1978

PROJECT FEATURE SPILLWAY BY CRG, TS, GC, TK

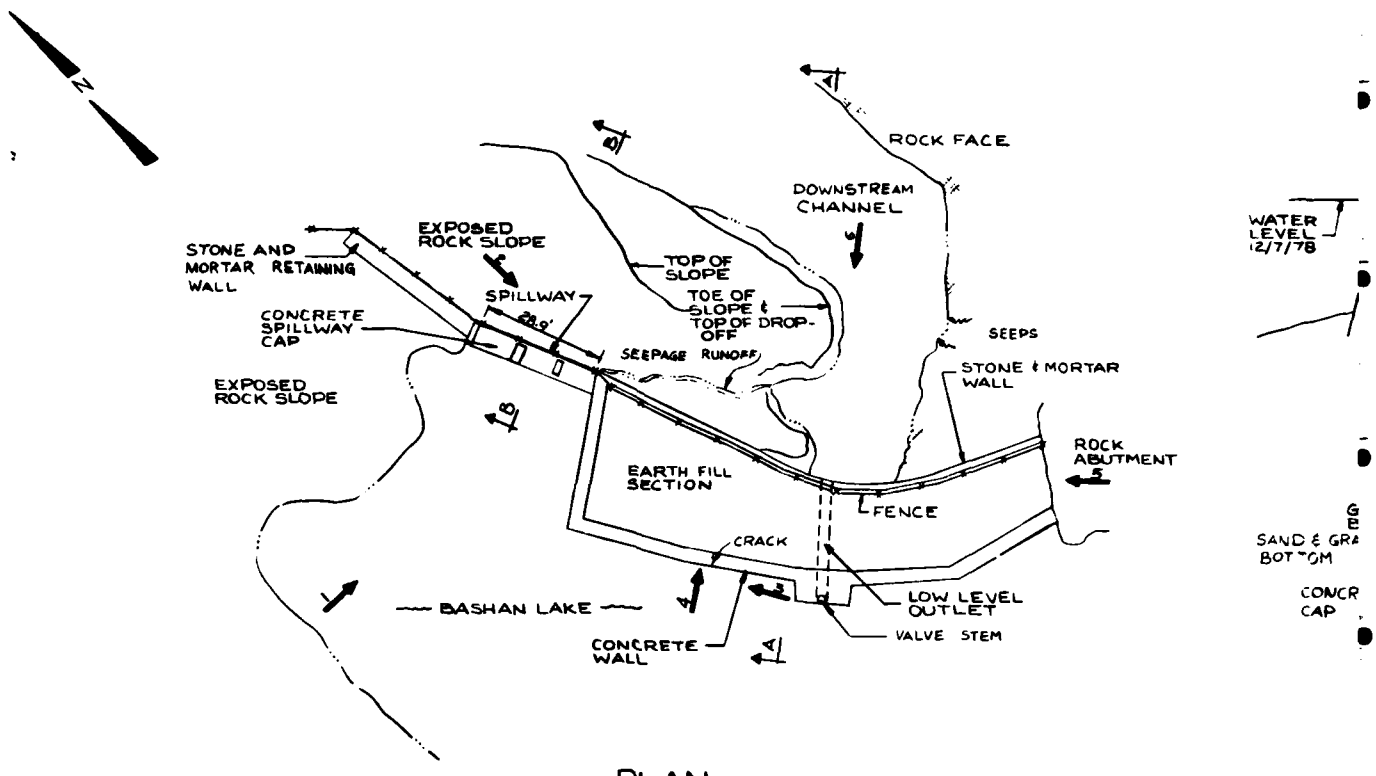
AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a) Approach Channel	
General Condition	FAIR - ALLOWS SEEPAGE UNDER SPILLWAY CAP
Loose Rock Overhanging Channel	NONE
Trees Overhanging Channel	NONE
Floor of Approach Channel	SAND AND GRAVEL - APPROX. 4H TO 1V SLOPE
b) Weir and Training Walls	
General Condition of Concrete	GUNNITE AND GRANITE BLOCK - GOOD CONDITION
Rust or Staining	NONE OBSERVED
Spalling	MINOR - GUNNITE SURFACE
Any Visible Reinforcing	NONE
Any Seepage of Efflorescence	NONE OBSERVED
Drain Holes	NONE OBSERVED
c) Discharge Channel	
General Condition	GOOD - NATURAL BEDROCK EXPOSURE
Loose Rock Overhanging Channel	SOME IN CHANNEL
Trees Overhanging Channel	SOME IN CHANNEL
Floor of Channel	BEDROCK
Other Obstructions	SOME TREES IN SPILLWAY DISCHARGE CHANNEL

APPENDIX

SECTION B: EXISTING DATA

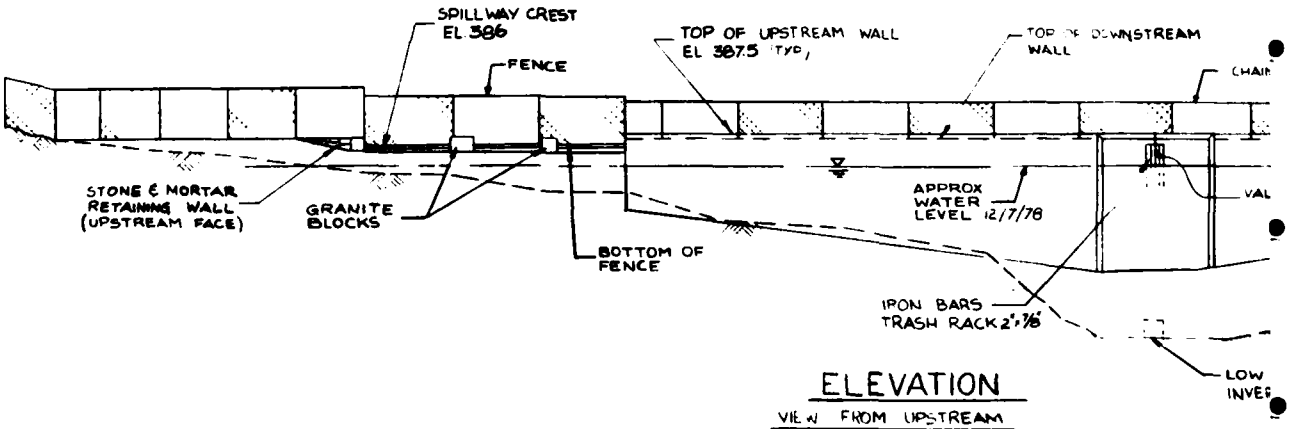
APPENDIX

SECTION B: EXISTING DATA
BASHAN LAKE DAM



PLAN

20' 0' 20' 40'

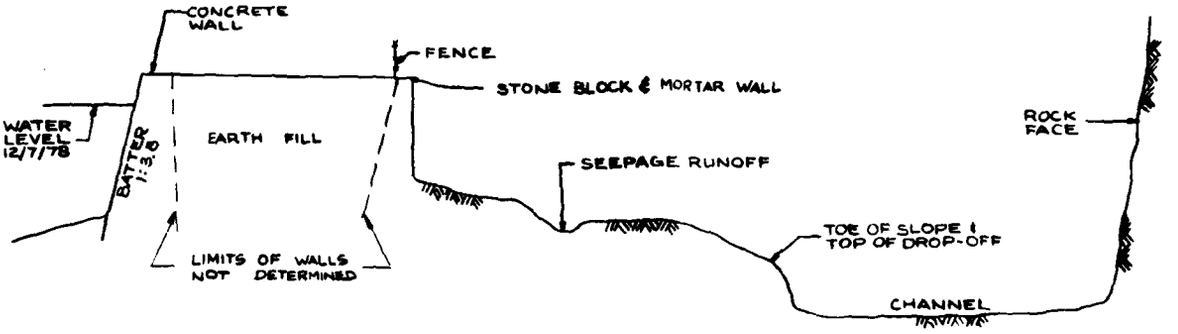


ELEVATION

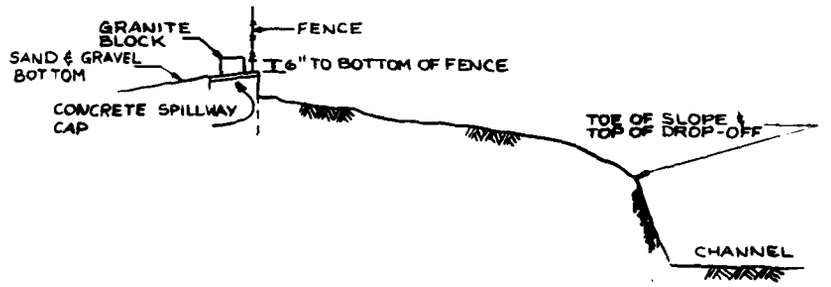
VIEW FROM UPSTREAM

10' 0' 10' 20' 30'

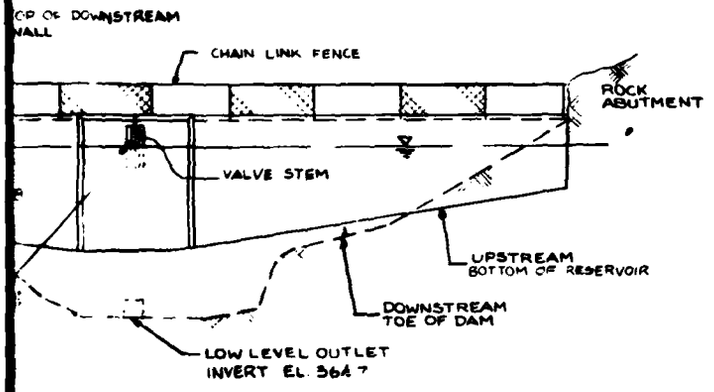
SCALE FOR ELEVATION & SECTIONS — HORIZ & VERT



SECTION A-A



SECTION B-B



1. THIS PLAN WAS COMPILED FROM ROUGH FIELD SURVEY; NO EXISTING PLANS WERE UTILIZED. DIMENSIONS SHOWN ARE APPROXIMATE. NOT ALL TOPOGRAPHIC AND/OR STRUCTURAL FEATURES ARE IDENTIFIED.

2. AS NO ELEVATIONS WERE AVAILABLE FOR THE DAM THE WATER SURFACE ELEVATION SHOWN ON THE U.S.G.S DEEP RIVER QUADRANGLE MAP WAS ASSUMED TO BE THE ELEVATION OF THE SPILLWAY CREST. ALL OTHER ELEVATIONS SHOWN ARE REFERENCED TO THE ASSUMED SPILLWAY CREST ELEVATION.

3. ← PHOTO NUMBER AND DIRECTION

CAHN ENGINEERS, INC WALLINGFORD, CONNECTICUT ENGINEER	U.S ARMY ENGINEER DIV NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

BASHAN LAKE DAM

MOODUS RIVER EAST HADDAM CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
AN	CAS	DMH	DATE FEB 1979	PAGE B-1

BASHAN LAKE DAM

LIST OF EXISTING PLANS

Plan Made for State of Connecticut
Department of Agriculture and Natural Resources
"Plan of Bashan Lake"
In the Town of East Haddam, Connecticut
May 25, 1967
Chandler & Palmer Engineers Norwich, Conn.
Sheet #1 of 2

Plan Made for State of Connecticut
Department of Agriculture and Natural Resources
"Showing Dam Site at Bashan Lake"
In the Town of East Haddam, Connectut
May 25, 1967
Chandler and Palmer Engineers Norwich, Conn.
Sheet #2 of 2

SUMMARY OF DATA AND CORRESPONDENCE

DATE	TO	FROM	SUBJECT	PAGE
No date	Files	State Board for the Supervision of Dams	Inventory Data	B-4
———	Publication - A Connecticut Fishery Survey	Fish and Waterlife, Conn. Dept. of Environmental Protection	Bashan Lake-Lake Bottom Contours	B-5

U

STATE BOARD FOR THE SUPERVISION OF DAMS
INVENTORY DATA

13

NAME OF DAM OR POND Bashan Lake CT-354

CODE NO. SL 2.0 M5.7 V0.7

LOCATION OF STRUCTURE:

Town East Haddam

Name of Stream Moodus River

U.S.G.S. Quad. Deep River Long. 72-30.0 Lat. 41-29.9

OWNER: Moodus Reservoir Company

Address East Haddam

Telephone

Pond Used For: Recreation

Dimensions of Pond: Width _____ Length _____ Area 1/2 mile ± 276 A±

Depth of Water below Spillway Level (Downstream) ~~4-30'~~ 25'

Total Length of Dam 150 Length of Spillway 25-30'

Height of Abutments above Spillway 1'-8"

Type of Spillway Construction concrete and stone

Type of Dike Construction stone and earth

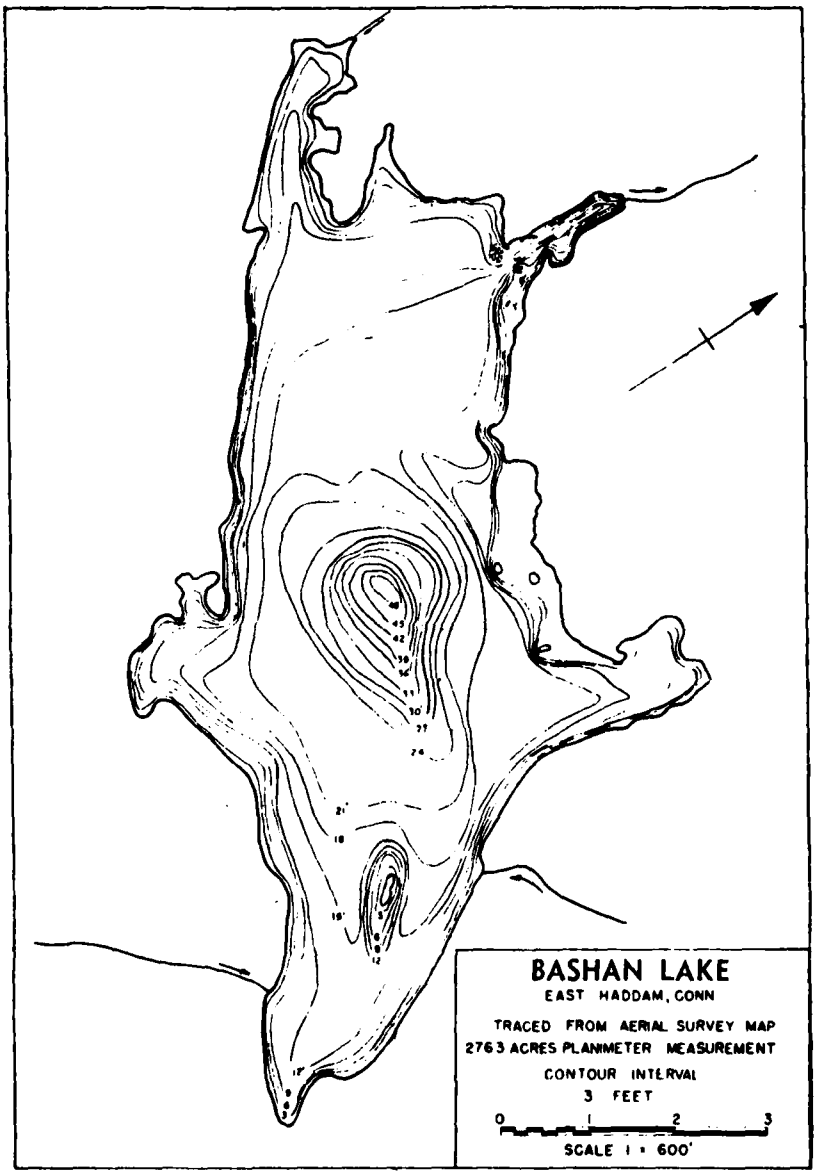
Downstream Conditions flows into Moodus Reservoir directly below

Summary of File Data

Remarks This structure is of major importance and Board member should inspect

B-4

1860?


BASHAN LAKE
EAST HADDAM, CONN
TRACED FROM AERIAL SURVEY MAP
2763 ACRES PLANIMETER MEASUREMENT
CONTOUR INTERVAL
3 FEET
0 1 2 3
SCALE 1 • 600'

B-5

APPENDIX

SECTION C: DETAIL PHOTOGRAPHS

PHOTO NO.1 - Upstream view of spillway.

PHOTO NO.2 - Downstream view of spillway and downstream face of dam.

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	Bashan Lake Dam
	INSPECTION OF	Moodus River
CAHN ENGINEERS INC. WALLINGFORD, CONN. ARCHITECT—— ENGINEER	NON-FED. DAMS	East Haddam, Connecticut
		CE # 27 595
		DATE Feb 1979 PAGE C-1

PHOTO NO.3 - Upstream face of dam with vertical cracking.

PHOTO NO.4 - Close-up view looking straight down at the above vertical cracking.

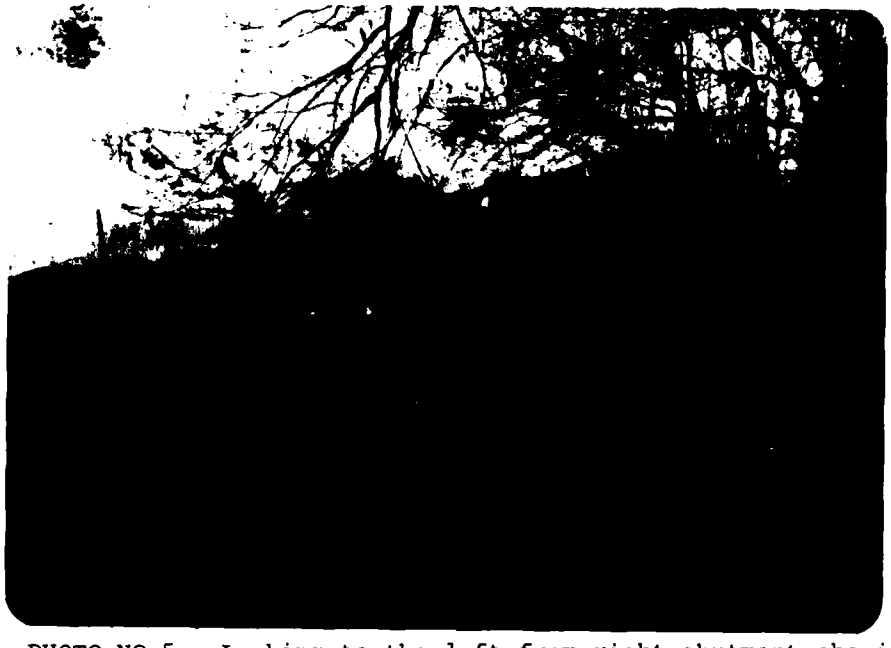


PHOTO NO.5 - Looking to the left from right abutment showing dam crest, downstream face of dam, and natural rock spillway channel.

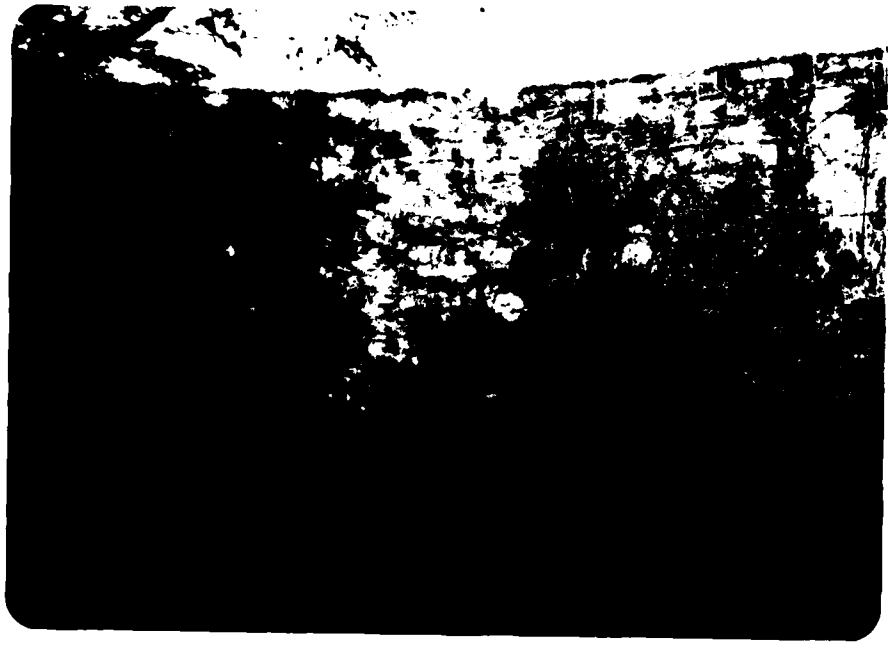


PHOTO NO.6 - Downstream face of dam, low level outlet, and natural rock outlet channel.

APPENDIX

SECTION D: HYDRAULIC/HYDROLOGIC COMPUTATIONS

PRELIMINARY GUIDANCE
FOR ESTIMATING
MAXIMUM PROBABLE DISCHARGES
IN
PHASE I DAM SAFETY
INVESTIGATIONS

New England Division
Corps of Engineers

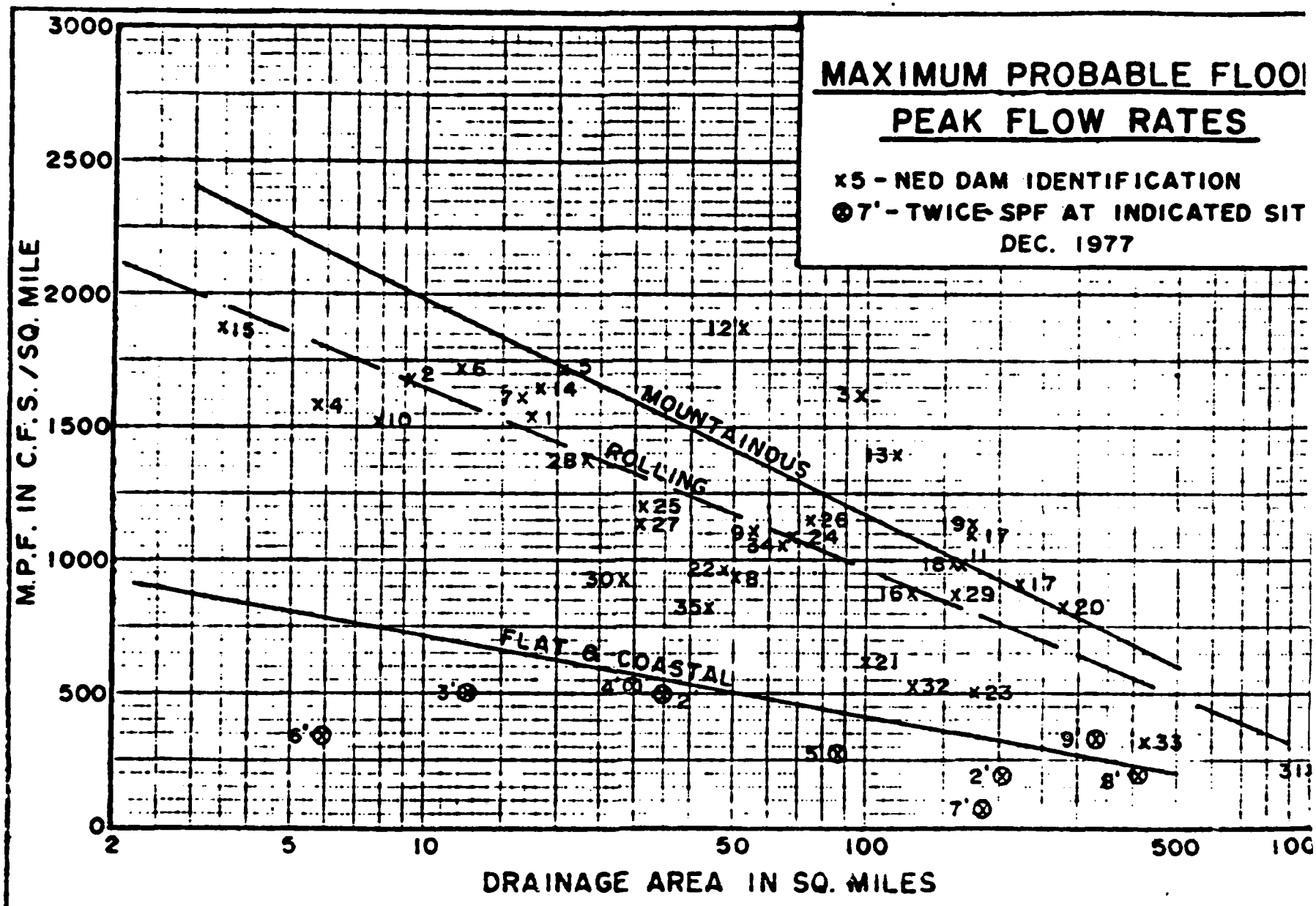
March 1978

MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

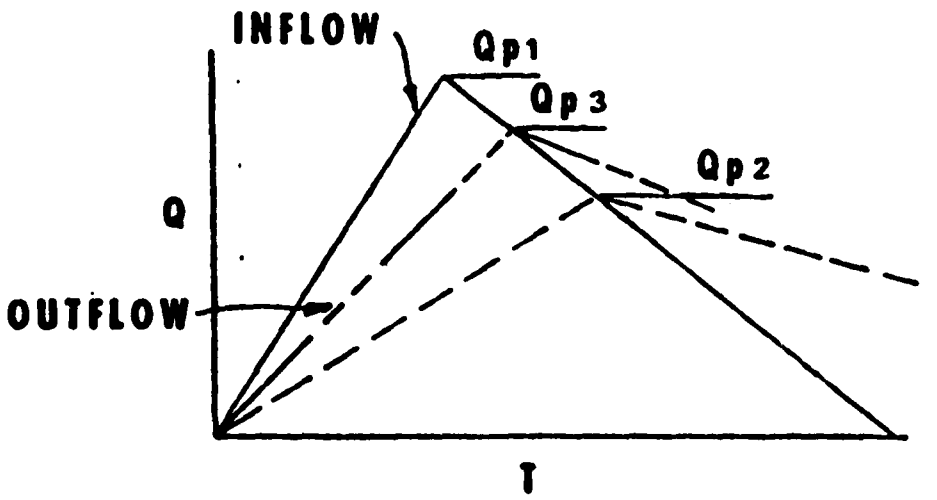
MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1. Pawtuxet River	19,000	200	190
2. Mill River (R.I.)	8,500	34	500
3. Peters River (R.I.)	3,200	13	490
4. Kettle Brook	8,000	30	530
5. Sudbury River.	11,700	86	270
6. Indian Brook (Hopk.)	1,000	5.9	340
7. Charles River.	6,000	184	65
8. Blackstone River.	43,000	416	200
9. Quinebaug River	55,000	331	330


MAXIMUM PROBABLE FLOOI
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SIT
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
MOUNTAINOUS
ROLLING
FLAT & COASTAL
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
x15
x4
x10
x2
x6
x14
x1
12x
3x
13x
28x
x25
x27
x26
x24
9x
x17
18x
x11
30x
22x
x8
16x
x29
x17
x20
35x
x21
x32
x23
x33
3'⊗
4'⊗
2
6'⊗
5⊗
9'⊗
2'⊗
8'⊗
7'⊗

D-4

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

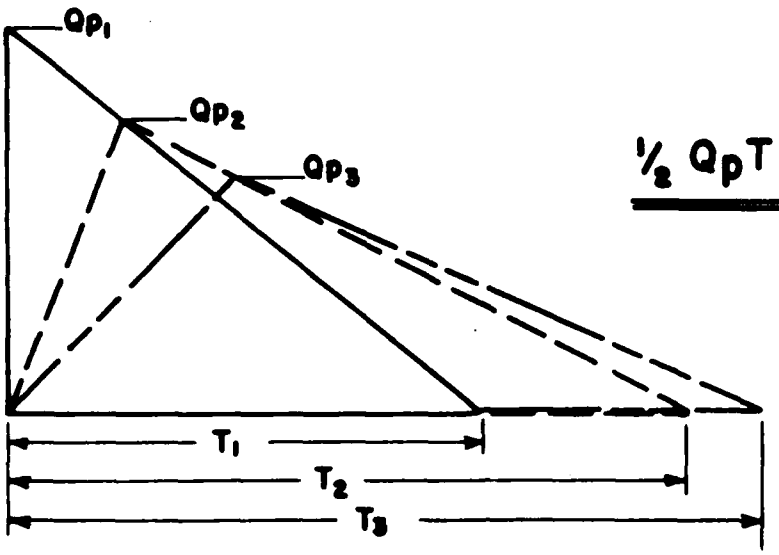
c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Q_{p_1} = \frac{8}{27} W_b \sqrt{g} Y_o^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Q_{p_2}(\text{TRIAL}) = Q_{p_1}\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Q_{p_2} = Q_{p_1}\left(1 - \frac{V_{AVG}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

HYDROLOGIC/HYDRAULIC INSPECTION

BASHAN LAKE DAM, EAST HADDAM, CT.

I) PERFORMANCE AT TEST FLOOD CONDITIONS:

1) MAXIMUM PROBABLE FLOOD:

a) WATERSHED CLASSIFIED AS "ROLLING"

b) WATERSHED AREA: D.A. = 2.0 SQ MI (U.S.G.S. HARTFORD OFFICE)

c) FROM NED-ACE "PRELIMINARY GUIDANCE FOR ESTIMATING MAX. PROB. DISCHARGES" - GUIDE CURVE FOR PMF - PEAK FLOW RATES:

PMF ≅ 2200 CFS/SQ MI

d) PEAK INFLOW: PMF = 2200 × 2 = 4400 CFS

2) SPILLWAY DESIGN FLOOD (SDF)

a) CLASSIFICATION OF DAM ACCORDING TO NED-ACE RECOMMENDED GUIDELINES:

i) SIZE*:

STORAGE (MAX)	≅ 3200 AC-FT	> 1000 AC FT
HEIGHT	≅ 23'	≅ 25 FT

*STORAGE: FROM U.S. INVENTORY OF DAMS DATED 1/18/74, STORAGE AT FLOW LINE 2760 AC-FT; AT MAX. POOL 2815 AC.FT.; HOWEVER, C.E. ROUGH CHECK BASED ON BASHAN LAKE MAP FROM "A CONNECTICUT FISHERY SURVEY" OF THE DEPT. OF FISHERY & GAMES FURNISHED BY CONN. D.E.P. WATER & REL. RES. SHOWS MAX. STORAGE TO BE > 3000 AC.FT. SAY, S = 2760 + 276 × 1.5 ≅ 3200 AC.FT (LAKE AREA ≅ 276 AC. FREEBOARD ≅ 1.5'); HEIGHT: ESTIM. FROM C.E. SURVEY OF DEC. 1978

BASHAN LAKE DAM.

2, a - Cont'd) CLASSIFICATION

ii) HAZARD POTENTIAL: THE DAM IS LOCATED JUST U/S OF MOODUS RESERVOIR WHICH HAS A SURFACE AREA OF ± 436 AC. ALONG THE NW SHORE OF MOODUS RESERVOIR THERE ARE SEVERAL HOMES ONLY 2.5 TO 4 FT. ABOVE THE RESERVOIR W.C. ALTHOUGH THE FLOOD WAVE THAT COULD BE GENERATED IN CASE OF THE FAILURE OF BASHAN LAKE DAM WILL BE DISSIPATED TO SOME DEGREE ENTERING MOODUS LAKE THESE HOMES COULD BE IN THE FLOOD WAVE PATH.

iii) CLASSIFICATION:

SIZE: INTERMEDIATE (S > 1000 AC FT)

HAZARD: SIGNIFICANT (THIS IS A TENTATIVE CLASSIFICATION FOR THE PURPOSE OF THIS COMP. - IT WILL BE REVISED AS THE ANALYSIS MAY INDICATE)

b) SDF = PMF = 4400 CFS $\frac{1}{2}$ PMF = 2200 CFS

3) SURCHARGE AT PEAK INFLOWS

a) PEAK INFLOW Q_I = 4400 CFS $Q'_I = \frac{1}{2}$ PMF = 2200 CFS

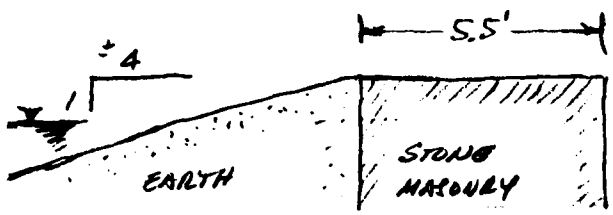
b) SPILLWAY (OUTFLOW RATING CURVE)

i) SPILLWAY (SEE SKETCH p. 3) THE SPILLWAY IS CLASSIFIED AS A BROADCRESTED WEIR OF TRAPEZOIDAL CROSS-SECTION WITH U/S INCLINED FACE (EARTH) ON 1 4 H TO 1 V SLOPE. THE CREST IS ± 29' LONG AND ITS BREADTH = 5.5' (CAHN

BASHAN LAKE DAM

3.0 Cont'd) OUTFLOW RATING CURVE.

ENGINEERS SURVEY DATED 12/18/78). THE TOP OF THE DAM IS (±) 1.5' ABOVE THE SPILLWAY CREST.



PRESENTLY THE SPILLWAY IS OBSTRUCTED BY WOOD PLANKS SERVING AS A BRIDGE SPANING THE SPILLWAY OVER 2 RECTANGULAR CONCRETE BLOCKS (PIERS) 1.2' AND 2.2' WIDE, RESPECTIVELY, AND A 6' (±) CHAIN LINK FENCE.

FOR THE PURPOSE OF THIS COMPUTATION, IT WILL BE ASSUMED THAT ALL THESE OBSTRUCTIONS HAVE BEEN REMOVED.

∴ SPILLWAY DISCHARGE COEFFICIENT, ASSUME: $C = 3.1$

∴ USING THE CREST ELEVATION AS DATUM, THE SPILLWAY DISCHARGE IS APPROXIMATED BY:

$$Q_S = 90 H^{3/2}$$

ii) EXTENSION OF RATING CURVE FOR SURCHARGE HEADS ABOVE TOP OF DAM.

THE DAM IS MADE OF A CONCRETE WALL U/S AND STONE MASONRY (GRANITE BLOCK) D/S WITH AN EARTH FILL CORE BETWEEN THE TWO STRUCTURES. THE TOP WIDTH VARIES FROM ± 20' TO 35' HAVING AN AVE. WIDTH OF (±) 28'. THE LENGTH (EXCLUDING THE SPILLWAY) IS (±) 140'. A (±) 6' CHAIN LINK FENCE EXTENDS

BASHAW LAKE DAM

3,6 - Cont'd) OUTFLOW RATING CURVE

ALONG THE ENTIRE LENGTH OF THE DAM AND CONTINUES ALONG THE ABUTTING LAND SLOPES AT THE LEFT SIDE OF THE DAM.
THE LEFT ABUTMENT RISES (±)5' IN A DISTANCE OF 20'
THE RIGHT ABUTMENT AFTER RISING (±) 4' VERTICALLY, CONTINUES AT APPROXIMATELY 2" TO 1' SLOPE (G.E. FIELD OBSERVATIONS)

WITHOUT THE FENCE, A COEFFICIENT OF $C_w = 2.5$ IS ASSUMED FOR THE FLOW OVERTOPPING THE DAM.-

CONDITIONS WILL BE ANALYZED WITHOUT CONSIDERING THE EFFECT OF THE FENCE WHICH DEPENDING UPON THE DEGREE OF CLOGGING/FAILURE WILL INCREASE TO SOME EXTENT THE SURCHARGE DEPTH.

ASSUMING EQUIVALENT LENGTHS FOR THE ABUTMENTS (L'_R ; L'_L) OF:

$$L'_R = \frac{2}{3}\left(\frac{2}{1}\right)(H-5.5) = 1.3\,(H-5.5) \quad \text{(NEGLIGEABLE)}$$

$$L'_L = \frac{2}{3}\left(\frac{20}{5}\right)(H-1.5) = 2.7\,(H-1.5)$$

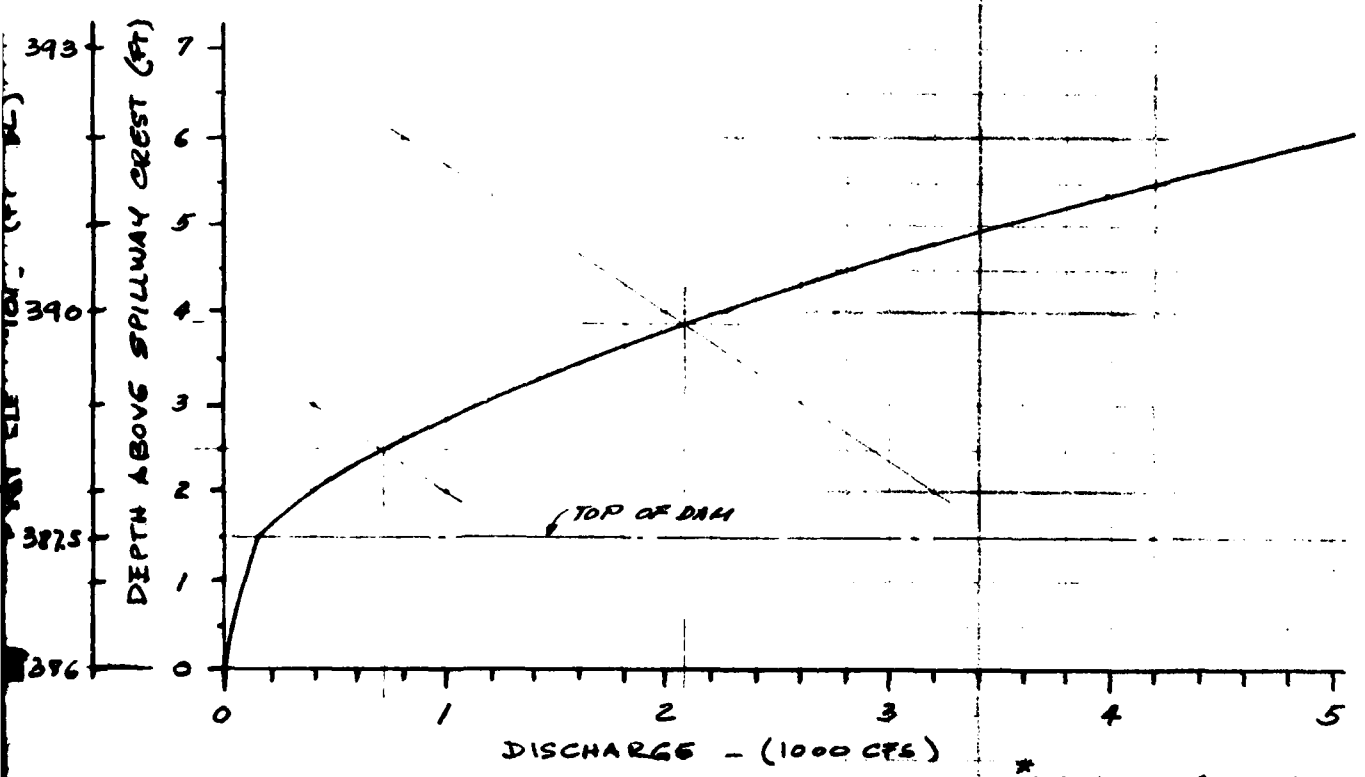
THE TOTAL OUTFLOW RATING CURVE CAN BE APPROXIMATED BY:

$$Q = 90H^{3/2} + 350\,(H-1.5)^{3/2} + 7\,(H-1.5)^{5/2}$$

THE OUTFLOW RATING CURVE IS PLOTTED ON NEXT PAGE

BASHAN LAKE DAM

3 - Cont'd) OUTFLOW RATING CURVE



* SEE NOTE IN SECT. 4.6 p.6

$$Q = 90H^{3/2} + 350(H-1.5)^{3/2} + 7(H-1.5)^{5/2}$$

c) SPILLWAY CAPACITY TO TOP OF DAM:

$H = 1.5'$ $\therefore$ $Q = 165^{CFS}$ $(3.8\%$ of Q_{P_1} ; 7.5% of $Q'_{P_1})$

d) SURCHARGE HEIGHT TO PASS Q_{P_1}:

i) @ Q_{P_1} = PMF = 4400^{CFS} $H_1 = 5.7'$

ii) @ $Q'_{P_1} = \frac{1}{2}$ PMF = 2200^{CFS} $H'_1 = 4.0'$

BASHAN LAKE DAM

4) EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES (OUTFLOW)

a) RESERVOIR (LAKE) AREA @ FLOW LINE: *$A_0 = 276$ AC.

*FROM DATA FURNISHED BY CONN. D.E.P.-WATER & RELATED RESOURCES:
"A CONNECTICUT FISHERY SURVEY" BASHAN LAKE MAP, P98
PLANIMETER MEASUREMENT FROM AERIAL SURVEY A=276.3 AC.
C.E. CHECK MEASURE: A=278 AC. ok

∴ ASSUME AVE. LAKE AREA WITHIN EXPECTED SURCHARGE, A=276 AC.

b) ASSUME NORMAL POOL LEVEL AT SPILLWAY CREST (ELEV. 386)
NOTE: U.S.G.S DEEP RIVER, CT. QUADRANGLE MAP M.L. ELEV. 386 IS ASSUMED TO BE (M) SPILLWAY CREST MSL. ELEV..

c) WATERSHED AREA: D.A. = 2.0 SQ MI (SEE P. 1)

d) DISCHARGE Q_{P_2} AT VARIOUS SURCHARGE ELEVATIONS:

$H=6'$ $V = 276 \times 6' = 1656$ AC FT ∴ $S = \frac{1656}{2 \times 53.3} = 15.5"$

$H=3'$ $V = 828$ AC FT ∴ $S = 7.77"$

$H=2'$ $V = 552$ AC FT ∴ $S = 5.18"$

∴ FROM APPROXIMATE STORAGE ROUTING NED-ACE GUIDELINES (19" MAX. PROBABLE R.O. IN NEW ENGLAND):

$Q_{P_2} = Q_{P_1}\left(1 - \frac{S}{19}\right)$ AND FOR ½ PMF: $Q'_{P_2} = Q'_{P_1}\left(1 - \frac{S}{9.5}\right)$

DH2

BASHAN LAKE DAM

4,d-Cont'd) DISCHARGE (Q_{P_2}) AT VARIOUS SURCHARGE ELEVS.

∴ FOR:

$H = 6'$ $Q_{P_2} = 800$ CFS

$H = 3'$ $Q_{P_2} = 2600$ CFS $Q'_{P_2} = 400$ CFS

$H = 2'$ $Q_{P_2} = 3200$ CFS $Q'_{P_2} = 1000$ CFS

e) PEAK OUTFLOW (Q_{P_3})

USING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING ALTERNATE" METHOD (SEE p. 5)

$Q_{P_3} = 2100$ CFS $H_3 = 3.9'$ FOR $Q_{P_1} = PMF$

$Q'_{P_3} = 700$ CFS $H'_3 = 2.5'$ FOR $Q'_{P_1} = \frac{1}{2}$ PMF

f) SPILLWAY CAPACITY RATIO TO OUTFLOW):

SPILLWAY CAPACITY TO TOP OF DAM: $Q_s = 165$ CFS

∴ SPILLWAY CAP. IS (±) 7.9% THE OUTFLOW @ PMF AND (±) 24% THE OUTFLOW @ ½ PMF.

5) SUMMARY:

a) PEAK INFLOW $Q'_{P_1} = \frac{1}{2}$ PMF = 2200 CFS TO $Q_{P_1} = PMF = 4400$ CFS

b) PEAK OUTFLOW $Q'_{P_3} = 700$ CFS TO $Q_{P_3} = 2100$ CFS

C) SPILLWY MAX. CAPACITY: $Q_s = 165$ CFS OR 24% OF Q'_{P_3} AND 7.9% OF Q_{P_3}

THEREFORE, AT SDF = ½ PMF THE DAM IS OVERTOPPED (±) 1.0' (MIN. EL. 385.5' MSL) OR TO AN AVE. SURCHARGE ABOVE THE SPILLWY CREST OF (±) 2.5'. THIS DOES NOT ACCOUNT FOR ADDITIONAL SURCHARGE PRODUCED BY THE FENCE AND OTHER EXIST. OBSTRUCTIONS

BAKHAN LAKE DAM

II) DOWNSTREAM FAILURE HAZARD

1) PEAK FLOOD AND STAGE IMMEDIATELY D/S FROM DAM.

a) BREACH WIDTH:

i) MID-HEIGHT (±) ELEV. 376' MSL ($\cong_N$ 90' C.E. SURVEY 12/7/78)

∴ ii) APPROX. MID-HEIGHT LENGTH $\ell \cong 42'$ (C.E. SURVEY MAP)

∴ iii) BREACH WIDTH (SEE NED-ACE DOWNSTREAM DAM FAILURE GUIDELINES)

$W = 0.4 \times 42 = 16.8$ ∴ ASSUME $W_b = \underline{15'}$

b) PEAK FAILURE OUTFLOW (Q_{P_1})

ASSUME SURCHARGE TO TOP OF DAM; THEREFORE,

i) HEIGHT AT TIME OF FAILURE: $Y_o = 101.5 - 78.4 \cong 23'$ (C.E. SURVEY)

ii) SPILLWAY DISCHARGE: $Q_s = 165^{CFS}$

iii) BREACH OUTFLOW (Q_b):

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2} \cong 2800^{CFS}$$

iv) PEAK FAILURE OUTFLOW (Q_{P_1})

$$Q_{P_1} = Q_s + Q_b \cong_N \underline{3000^{CFS}}$$

BASNAN LAKE

1-Cont'd) DOWNSTREAM FAILURE HAZARD

c) FLOOD WAVE HEIGHT IMMEDIATELY D/S OF DAM:

$Y \cong 0.44\, Y_o \cong \underline{10'}$

2) ESTIMATE OF DOWNSTREAM DAM FAILURE CONDITIONS AT IMPACT AREA.

(SEE NED-ACE "RULE OF THUMB" GUIDELINE FOR ESTIMATING HYDROGRAPHS)

THE DAM IS LOCATED (±) 300' U/S FROM MOODUS RESERVOIR (SEE SECT. J,2,a p. 2) WHICH HAS SOME HOMES ONLY 2.5' TO 4' ABOVE THE RESERVOIR LEVEL.
TWO ANALYSES WILL BE MADE FOR THE FLOOD REACHING MOODUS RESERVOIR:

a) RAISE OF THE RESERVOIR WATER LEVEL ASSUMING FLOOD UNIFORMLY DISTRIBUTED OVER THE RESERVOIR
b) WATER DEPTH AT THE OPPOSITE SHORELINE TO THE RACE AT WHICH A FLOOD WAVE WOULD ENTER THE RESERVOIR.

IN BOTH ANALYSES THE FLOOD WAVE ENTERING THE RESERVOIR WILL BE ASSUMED UNMODIFIED BY THE SHORT CHANNEL BETWEEN THE DAM AND THE RESERVOIR.
THE SECOND ANALYSIS WILL BE MADE BECAUSE AT LEAST ONE OF THE LOW HOUSES (± 3.5' ABOVE RES. W.L.) WOULD BE ON THE ASSUMED FLOOD WAVE (SURGE) PATH.

a) RAISE OF MOODUS RESERVOIR WATER LEVEL BECAUSE OF FAILURE OF BASNAN DAM.

b) VOLUME OF STORAGE AT TIME OF FAILURE (BASNAN) $S \cong \underline{3200}$ AC.FT (FROM P. 1)

BASHAN LAKE

2,a -Cont'd) RAISE OF WL @ MOODUS RES.

ii) MOODUS RES. DATA (FROM D.E.P. WATER & ECOLOGICAL RESOURCES)

SPILLWAY: BROAD CRESTED, 140' LONG; FREEBOARD 2.5'
DIKE: (W/o SPILLWAY), 135' LONG
LAKE AREA: $A_N = 436$ AC.

iii) ASSUME MOODUS SPILLWAY $C = 3.1$; DIKE $C_N = 2.7$

$\therefore Q = 440H^{3/2} + 370(H-2.5)^{3/2}$

iv) ESTIMATE OF WATER DEPTH:

@ $Q_1 = 3000$ CFS SURCHARGE: $H_1 = 3.4'$

STORAGE $S_1 = 3.4 \times 436 = 1480$ AC-FT

$Q_2 = 3000\left(1 - \frac{1480}{3200}\right) = 1600$ CFS

@ $Q_2 = 1600$ CFS $H_2 = 2.4'$ $S_2 = 1050$ AC-FT $S_{AVG} = 1270$ AC-FT

$\therefore Q_3 = 1800$ CFS $H_3 = 2.6'$

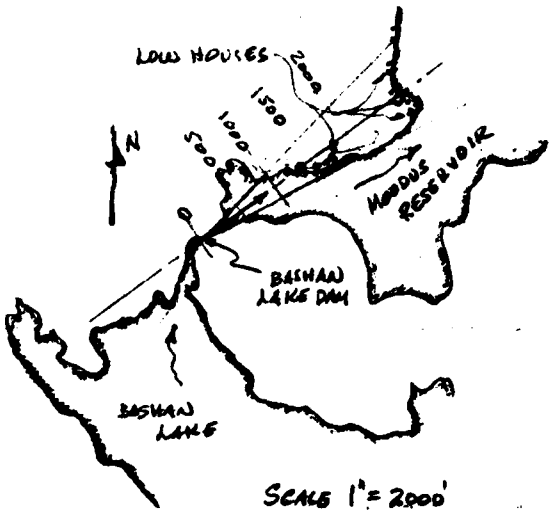
$\therefore$ ESTIMATED WATER LEVEL RAISE AT MOODUS RESERVOIR BECAUSE OF FAILURE OF BASHAN LAKE DAM = 2.6' OR (±) THE FLOOR LEVEL OF THE LOW HOUSES AT THE SHORELINE.

BASHAN LAKE

2 - Cont'd) DOWNSTREAM DAM FAILURE CONDITIONS AT IMPACT AREA

b) ESTIMATE OF WATER DEPTH AS THE FLOOD WAVE ENTERING THE RESERVOIR IMPACTS THE SHORELINE.

A(I) 10' HIGH FLOOD WAVE (INSTANTANEOUS $Q = 3000^{CFS}$) GENERATED UPON FAILURE OF BASHAN LAKE DAM, WOULD ENTER MOODUS LAKE AND MOVE ACROSS THE RESERVOIR TO THE OPPOSITE SHORE (±) 1500' D/S FROM THE DAM. (SEE SKETCH)



SCALE 1" = 2000'

A ROUGH ESTIMATE (CONSERVATIVE) OF THE WATER DEPTH CAN BE MADE BY MOMENTUM BALANCE BY ASSUMING THE WAVE RIDING OVER THE LARGE RESERVOIR'S WATER BODY AND EXPANDING GRADUALLY RH & G LONG. TO 1 TRANSV. RATIO. FROM ITS ORIGINAL 10' HIGH X 15' WIDE RECTANGULAR CROSS-SECTION.

THE SPECIFIC FORCE FOR THE RECTANGULAR SECTION OF WIDTH (T) AND HEIGHT (H):

$$\frac{P_T M}{\omega} = \frac{Th^2}{2} + \frac{Q^2}{gTh}$$

FOR THE ORIGINAL SECTION $T_1 = 15'$ $h_1 = 10'$ $Q = 3000^{CFS}$
THE SPECIFIC FORCE IS (±) 2600 #/#/FT²
FOR EXPANDED SECTIONS AT $L = 1000'$; $L = 1500'$ AND $L = 2000'$
WITH ASSUMED WIDTHS $T_2 = 350'$; $T_2 = 500'$ AND $T_2 = 670'$ THE

BASHAN LAKE

2,b - Cont'd) DEPTH OF WATER AT SHORELINE

CORRESPONDING WATER DEPTHS TO BALANCE THE INITIAL SPECIFIC FORCE ARE APPROXIMATELY:

L	T_2	h_2
1000'	350'	3.7'
1500'	500'	3.2'
2000'	670'	2.7'

SO THE ESTIMATED MAX. WATER DEPTH EXPECTED AT SHORELINE IS OF THE ORDER OF 2.5' TO 4' OR APPROX. THE FLOOR LEVEL OF THE LOW HOUSES OF MOODUS RESERVOIR.

3) SUMMARY:

a) PEAK FAILURE OUTFLOW: $Q_p \cong 3000$ CFS

b) FLOOD WAVE HT. IMMEDIATELY AT DAM: $y \cong 10'$

c) CONDITIONS AT MOODUS RESERVOIR:

i) PEAK OUTFLOW AT MOODUS RES. DAM: $Q_{p_M} = 1800$ CFS.

ii) SURCHARGE DEPTH AT MOODUS RES.: $h_2 \cong 2.6'$

iii) MAX. FLOOD WAVE DEPTH AT SHORE: 2.5' TO 4' (ABV. MOODUS RES. W.L. $\cong$ 360' MSL)

APPENDIX

SECTION E: INVENTORY OF DAMS IN UNITED STATES

INVENTORY OF DAMS IN THE U...ED ST...

IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
354	NED	CT	007	02				BASHAN LAKE DAM	4129,9	7225,0	18JAN74

Dean River CT

F-11

POPULAR NAME	NAME OF IMPOUNDMENT
	BASHAN LAKE

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	MOUOUS RIVER	BASHAN	1	500

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
RECROT	1860	R	26	25	2815	2760

DIST OWN FED H PRV/FED SCS A VEH/DATE

NED

REMARKS
20-ESTIMATE 21-STONE 22-ESTIMATE

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)

OWNER	ENGINEERING BY	CONSTRUCTION BY

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION

REMARKS

E-1

REPORTS CONTROL SYMBOL
DASN-CWE-17


FILM